CLEVE HILL SOLAR PARK

ENVIRONMENTAL STATEMENT

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CHAPTER 15 - CLIMATE CHANGE

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15 CLIMATE CHANGE

15.1 Introduction

1. This chapter of the ES evaluates how the Development is likely to interact with a changing climate and whether any significant effects could arise. Climate Change Impact Assessment (CCIA) is a relatively new form of environmental assessment required by amended European Commission (EC) Directive 2014/52/EU1, as transposed into UK law by the EIA Regulations.

15.1.1 Development Parameters Assessed

2. The Rochdale Envelope parameters for the Development have been considered with respect to the potential effects considered in this Chapter, and typically worst-case values/scenarios for this are captured by the candidate design, as set out in Chapter 5: Development Description. This chapter generally reports the assessment of effects associated with the candidate design. The exception to this is when considering the potential generation of electricity from the Development, and for these purposes an alternative design has been used that was developed during the design process for the Development, but which has a lower installed direct current (DC) capacity (330 MWp) than the candidate design (349 MWp). This was done because the candidate design maximises generation, because this maximises land-take and is therefore generally a worst-case with respect to adverse environmental effects, but is best-case with respect to the generation of electricity. The approach taken in this chapter is therefore conservative and precautionary.

15.1.2 Consultation

3. Information has been provided by a range of organisations during the work leading up to the ES, and those aspects relating to climate change are summarised in Table 15.1a. The response to each point raised by consultees is also presented within the table, demonstrating where the design of the Development has changed in response to specific issues indicated consultees, or where the comment has otherwise been addressed in this chapter.

Table 15.1a Consultation Responses

Consultee	Summary of Consultation Response	Applicant Response
PINS Scoping response January 2018	In accordance with the EIA Regulations, the ES should include a description of the potential vulnerability of the Proposed Development to risks of major accidents and/or disasters, including vulnerability to climate change, which are relevant to the Proposed Development. This should include consideration of whether the Proposed Development itself has the potential to cause accidents or disasters during construction, operation or decommissioning. The Scoping Report does not set out the proposed approach to considering major accidents and disasters in the ES.	The potential vulnerability of the Proposed Development to climate change is considered in section 15.4.1. Consideration of major accidents/disasters is presented in Chapter 17: Miscellaneous Issues. Section 15.4.1 discusses the Development's potential vulnerability to severe weather, which is covered more thoroughly with respect

[1] European Commission (2014) Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment [Online] Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0052&from=EN (Accessed 10/05/2018)

Consultee	Summary of Consultation Response	Applicant Response
	The Inspectorate considers that given the coastal location of the application site, the Proposed Development is potentially vulnerable to severe weather (such as storms and floods, the risks of which may be exacerbated by climate change). As such, the description in the ES regarding vulnerability to major accidents/and or disasters may be cross-referenced to the Climate Change Impact Assessment where appropriate.	to flooding in Chapter 10: Hydrology, Hydrogeology and Ground Conditions.
	The sensitive receptors for the purposes of the CCIA should be set out and justified in the ES. The susceptibility or resilience of the identified receptors to climate change must be considered as well as the value of the receptor.	This CCIA chapter has three parts. In the first part, the Development itself is the receptor. In the second, the climate itself is the receptor. In the third, the receptors are receptors considered in other chapters.
	The assessment should take account of the 2017 IEMA guidance document 'Assessing Greenhouse Gas Emissions and Evaluating their Significance'.	Section 15.4.3 considers the IEMA guidelines.
	The ES should specify the calculation methods used to quantify the greenhouse gas emissions relating to the Proposed Development.	Section 15.4.3 specifies the calculation methods.
	As set out in NPS EN-1 the assessment of potential impacts of climate change should use the latest UK Climate Projections, this should include the anticipated UKCP18 projections where appropriate. For the avoidance of doubt the Inspectorate's comments in this regard are also included in Table 4.4 (Hydrology, Hydrogeology, Flood Risk and Ground Conditions) of this Opinion.	At the time of writing, UKCP18 is not available. Section 15.3 considers the use of UKCP09 as the latest UK Climate Projections.
	The study area for the assessment should be clearly defined in the ES.	This CCIA chapter has three parts. In the first part, the Development itself is the receptor. In the second, the climate itself is the receptor. Neither of these have relevant study areas. In the third, the receptors are receptors considered in other chapters, with corresponding study areas.
	The Scoping Report does not set out how a significant effect would be determined for the purposes of the CCIA. This should be clearly set out in the ES. Any use of professional judgement to assess significance should be fully justified within the ES.	Section 15.2.5 discusses the IEMA guidelines for significance criteria for the purposes of the CCIA.

Consultee	Summary of Consultation Response	Applicant Response
	Cumulative impacts from increased greenhouse gas emissions with the potential to result in significant effects should be identified and assessed in the ES.	Cumulative impacts are discussed in section 15.6.
Environment Agency Letter May 2018	The Environment Agency does not own the land or the defences at this location. Therefore there is no legal obligation for us to undertake maintenance, and any works carried out in the past have been done so using permissive powers. The proposed policy set out within MEASS will become adopted once the strategy is officially signed off. We would therefore respond to any formal Development Consent Order application stating, as outlined within MEASS, that publicly funded maintenance of the defences is not economically viable without the associated justification of managed realignment in the future. We would expect major infrastructure owners such as CHSPL, National Grid and BTLAL to undertake maintenance of the defences whilst occupying the site. In the case of CHSP, we would expect this to come into effect once construction / use of the site commences. We discussed your proposal to extend the CHSP red line boundary to include the flood defences protecting the site, and the inclusion of powers and rights in your DCO to enable CHSPL to undertake maintenance works to the defences. We would not have any concerns or objections with this approach in order to give CHSPL the ability to maintain the defences in the future.	Section 15.4.1 discusses the vunerability of the Development to the effects of climate change. In light of the EA's response, the Applicant has included the flood defences in the Application red line boundary and seeks the necessary powers to allow CHSPL to undertake maintenance activitys and preserve the existing level of flood protection afforded to the Development site throughout its operational lifetime.

4. The Preliminary Environmental Information Report (PEIR) was completed in May 2018. A summary of key Section 42 consultation responses following submission of the PEIR and which are either addressed in the assessment or have been taken into account during the design of the final layout are provided in Table 15.1b. Full details of consultation details are provided in the Consultation Report (DCO Document Reference 5.1) submitted as part of the Application.

Table 15.1b Key Consultation Responses (PEIR)

Consultee	Response	Applicant Response
CPRE Kent	We recognise the challenges of climate change and the Government's commitment to meeting its carbon emission targets, but we do not consider the renewable energy benefits of this project can outweigh the harm it will cause to the environment of the marshes (indeed, we also question the sustainability of reliance on lithium-ion battery technology with its own remote but very real ecological impacts).	The climate change benefits of the Development are assessed in this chapter, section 15.5.2. The benefits to the electrical grid network of the battery aspects of the Development are set out in section 15.4.2, with further discussion in the Need Statement (DCO Document Reference 7.3).

Consultee	Response	Applicant Response
Faversham Footpath Groups	Like the great majority of people, our members share the wish to see more of our energy generated from renewable sources and to see carbon emissions reduced. We understand that it is vital that governments take urgent action to halt climate change and that this means, with present technologies, that we must look to wind and solar power in particular to compensate for carbon-based fuels. Offshore in Kent, we already have major windfarms, while, onshore, there are already a number of smaller solar farms, but nothing anywhere near approaching the size of this proposed development, which we understand, is some four times larger than any existing solar park in the UK.	At the time of writing, the largest solar PV scheme in the UK is approximately 50 MWp, and on this basis the Development would be capable of producing around seven times more renewable energy.
Graveney with Goodnestone Parish Council	We accept that the UK has international obligations, statutory goals and planning policies to increase the role of renewable energy. We also accept that achievement of these goals should assist in managing and mitigating the impacts of climate change. However, this does not mean that all renewable energy projects are acceptable, particularly if they have a significant and harmful impact on their host environment. There is a balance to be struck and national and local planning policies (see section 5 above) set out some of the planning considerations that need to be taken into account.	The ES provides an overview of applicable policies so far as they relate to the method of assessment. However, it is not the role of the ES to assess compliance with planning policy regarding the benefits of the Development nor opine on the planning balance; commentary on these aspects is made in the Planning Statement (DCO Document Reference 7.4).
GREAT Graveney	Can a proper and accurate calculation of CO_2 costs be undertaken showing how this was worked out, including all equipment, and associated costs such as transport and decommissioning?	The sources of information used for the climate change impact assessment in the ES, are referenced in section 15.4.2, and include all life-cycle CO_2 costs for the Development, where information is available. Aspects for which CO_2 costs are not available are identified.
Kent Wildlife Trust	We are generally supportive of initiatives to reduce human reliance on fossil fuel energy generation, and renewable energy no doubt has a role to play in this. However, this should not be at the expense of the natural environment. The proposals set out in this consultation will result in significant impacts on wildlife and are unacceptable.	Since PEIR, the proposals, including mitigation, have been revised in order to reduce the impacts on wildlife, as set out in the ES Technical Appendix A5.2 Landscape and Biodiversity Management Plan, and Chapter 8, Ecology, and Chapter 9, Ornithology.
Swale Friends of the Earth	Friends of the Earth campaigns to change the world for good, creating a cleaner, healthier, fairer world for everyone, for today and generations to come. Swale Friends of the Earth (Swale FoE) is affiliated to national Friends of the Earth and is a group of local volunteers aiming to increase environmental awareness locally and bring a different perspective to debates in Swale. Our current campaign priorities are climate change, plastic pollution, biodiversity (e.g. the FoE bee campaign), sustainable transport and traffic, food and sustainable development (housing, etc.).	No comment required.

15.1.3 Legislation, Policy and Guidance

5. The Climate Change Act 2008[2] established the context for UK government action. A National Adaption Programme[3] addressed the main risks and opportunities identified in the UK Climate Change Risk Assessment for England.

6. In terms of planning, the UK Government addresses climate change through National Policy Statements (NPS) and National Planning Policy Framework (NPPF)[4]. This recognises that planning plays a key role in minimising vulnerability, providing resilience and managing the risks associated with climate change. NPPF does not make specific reference to the EIA's role in mitigating and adapting to climate change; however, it does support the transition to a low carbon future as a core planning principle to help reduce England's carbon emissions and adapt to climate change.

7. Currently only provisional guidelines exist to standardise the CCIA process in the UK. The Institute of Environmental Management and Assessment (IEMA) published 'Environmental Impact Assessment Guide to Climate Change Resilience and Adaption' in November 2015[5], with the intention of providing an updated and finalised version when the EC Directive was transposed into UK law. In 2017 they published 'Environmental Impact Assessment Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance'[6]. These documents provide the framework for the assessment reported in this chapter.

15.2 Assessment Methodology and Significance Criteria

8. Future climate projections are published by the Met Office through the UK Climate Projections website. The UK Climate Projections Report 2018 (UKCP18) is expected to be available in November 2018; however, at the time of writing, the current projections available are supplied from the Climate Change Projections Report 2009 (UKCP09)[7], which remains the official source of information on how the climate of the UK may change over this century[8]. For this assessment the UKCP09 medium emissions scenario (A1B) (central estimate) have been utilised as the future baseline. This scenario is based on a future of rapid economic growth and the rapid introduction of new, more efficient technologies with a balance of non-fossil fuel and fossil fuel intensive energy technologies. The worst-case emissions scenario (A1F1), which is based on fossil fuel intensive energy technologies only, would be an extremely unlikely future scenario and therefore the medium emissions scenario is considered the most appropriate for this assessment.

9. The following assessment areas are considered in terms of the Development:

- The vulnerability of the Development to climate change;
- The influence of the Development on climate change; and

[2] UK Government (2008) Climate Change Act 2008 [Online] Available at: https://www.legislation.gov.uk/ukpga/2008/27/contents (Accessed 10/05/2018)
[3] UK Government (2013) The National Adaption Programme [Online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/209866/pb13942-nap-20130701.pdf (Accessed 10/05/2018)
[4] UK Government (2012) The National Planning Policy Framework [Online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf (Accessed 10/05/2018)
[5] IEMA (2015) IEMA Environmental Impact Assessment Guide to Climate Change Resilience and Adaption [Online] Available at: https://www.iema.net/assets/templates/documents/iema_guidance_documents_eia_climate_change_resilience_and_adaptation%20(1).pdf (Accessed 10/05/2018)
[6] IEMA (2017) IEMA Environmental Impact Assessment Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance' [Online] Available at: https://www.iema.net/policy/ghg-in-eia-2017 (Accessed 25/10/2018)
[7] UKCP (2009) Climate Projections Report (version 2, July 2009) [Online] Available at: http://ukclimateprojections.metoffice.gov.uk/22530 (Accessed 25/10/2018)
[8] UKCP18 Project Q&A. http://ukclimateprojections.metoffice.gov.uk/24126 (Accessed 25/10/18)

- A summary of effects on environmental receptors sensitive to climate change.

10. The assessment of the vulnerability of the Development to climate change considers effects on the Development as a receptor. In contrast the other two assessments consider effects on environmental receptors as a result of the Development.

15.2.1 Vulnerability of the Development to Climate Change

11. This section of the CCIA identifies aspects of the Development which are potentially vulnerable to the effects of climate change. Where identified, these vulnerabilities can then be mitigated through embedded mitigation or the application of other measures.

12. Taking into account the exposed nature and coastal location (protected by a coastal flood defence) of the Development site, the following climate-related parameters are considered to have the potential to effect on the Development and the surrounding environment:

- Temperature
- Wind Speed;
- Sea Level;
- Storm Surges; and
- Cloud Amount.

13. Variation in other climatic factors would not have the potential to substantially affect the Development.

15.2.2 Influence of the Development on Climate Change

14. This section of the CCIA seeks to quantify the effect of the Development on climate change in order to undertake an assessment of significance of the effect. The predicted greenhouse gas emissions, and emissions saving of the Development will be calculated and used to undertake this assessment.

15.2.3 Effects on Environmental Receptors Sensitive to Climate Change

15. A number of climatic parameters are relevant to environmental receptors that have the potential to be impacted by the Development, including changes in temperature and precipitation. The sensitivity of these receptors is taken into account in the assessments undertaken elsewhere in this ES.

15.2.4 Assessment Limitations

16. It is important to note that climate change projections are based on global models for a range of greenhouse gas emissions scenarios and generally consider regional responses to climate change rather than local. For this assessment, local data (based on a 25 km grid square) has been obtained from the UKCP09 for assessing sea level changes, however, regions (*e.g.*, southeast England) and national (e.g., UK wide) data has been used to inform the assessments of all other climatic considerations.

17. The UK Climate Projections (UKCP09) website[9] provides future climate projections for land and marine regions as well as observed climate data for the UK. Future predictions for regional and national climatic changes are assessed for both a near-term period, 2040 – 2069, and longer-term period, 2070 – 2099.

[9] UKCP09 (2016). UK Climate Projection. [Online] Available at: http://ukclimateprojections.metoffice.gov.uk/ (Accessed: 10/05/2018)

15.2.5 Significance Criteria

18. The IEMA guidelines for CCIA state the following with regards to the assessment of significance:

> *This guidance is not proposing changes to the significance criteria used in the EIA process. However, the susceptibility or resilience of the receptor to climate change must be considered as well as the value of the receptor.*
>
> *Therefore, a high-value receptor that has very little resilience to changes in climatic conditions should be considered more likely to be significantly affected than a high-value receptor that is very resilient to changes in climatic conditions.*
>
> *The uncertainty of the combined effect needs to be taken into account. If uncertainty about how a receptor will adapt to a changing climate is high, then it is recommended that a conservative threshold of significance is adopted within the evaluation."*

19. To determine whether effects are significant under the EIA Regulations, is it appropriate to consider the sensitivity (value and resilience) of the receptor and the magnitude of the effect, taking into account uncertainty. This is based on the professional judgement of the assessor.

20. Section 2.1.3 of Chapter 2: Environmental Impact Assessment details the categories of significance which effects are assessed as being:

- Negligible – no detectable or material change to a location, environment, species or sensitive receptor;
- Minor – a detectable but non-material change to a location, environment, species or sensitive receptor;
- Moderate – a material, but non-fundamental change to a location, environmental, species or sensitive receptor; or
- Major – a fundamental change to location, environment, species or sensitive receptor.

21. Significance combines the sensitivity of climate change receptors with the magnitude of the effect. Whilst receptors may be considered "high-value", a non-material magnitude of effect would result in any effect being considered not significant. Section 15.4 details the assessment for each receptor.

15.3 Baseline Conditions

15.3.1 Current Climate Baseline

22. The UK Climate Projection Report: The Climate of the UK and Recent Trends[10] provides observed climate data for UK Regions. Table 15.2 indicates the observed changes in climatic variables between 1961 and 2006 (reported at the 95% confidence level) for the southeast of England where the Development is located.

Table 15.2 Observed Changes in Climate Variables for the southeast of England (1961-2006)

Climate Variables	Annual Observed Change (1961 – 2006)
Daily mean temperature	+ 1.62 degrees Celsius (°C)
Daily maximum temperature	+ 1.75 °C
Daily minimum temperature	+ 1.50 °C

[10] Jenkins *et al.,* (2008). The Climate of the UK and Recent Trends. Met Office, Hadley Centre, Exeter, UK.

Climate Variables	Annual Observed Change (1961 – 2006)
Change in days of air frost	- 23.4 days
Change in cooling degree days	+ 26.9 days
Change in heating degree days	- 18.3 days
Change (days) in days of rain > 1mm	- 0.9 days
Percentage change in total precipitation	+ 5.4 %
Change in mean sea-level pressure (hectopascal (hPa))	- 0.4 hPa
Change in relative humidity	- 3.8%

15.3.2 Future Baseline – Climate Projections Relevant to the Assessment

23. The climate parameters considered relevant to the assessments referenced within this CCIA are temperature, wind speed, sea level, storm surges, and cloud amount. In addition to these, changes in temperature could potentially affect environmental receptors considered elsewhere in this ES, although not directly considered to inform assessment within this CCIA. It should be noted that climate change does not necessarily mean warming of the climate at a specific location. Changes in local climate depend in a complex way on global temperature rise, and in the UK are expected to include a rise in the frequency of more extreme weather events, and average or long-term statistics would not capture this.

15.3.2.1 Temperature

24. This section is based on the UK Climate Projections Science Report, tables 4.1 and 4.4, which has predicted summer and winter temperatures for 2040 – 2069 and 2070 – 2099 relative to 1961 – 1990. As the Development operational phase is not limited, time periods 2040 – 2069 and 2070 – 2099 provide the closest and furthest projection periods available to the operational phase of the Development, at the time of writing. For the purpose of this assessment, predicted values for the 2040 – 2069 and 2070 – 2099 period have been used.

25. Table 15.3 shows future baseline temperature predictions for southeast England, at the 50% probability level (under the medium emissions scenario). The southeast of England showed the highest changes in temperature of all UK regions.

26. For 2070 – 2099 temperatures, only UK wide projections are available; the UK Climate Projections Science Report table 4.1 presents a range of the lowest change in the UK to the highest change in the UK. The highest change has been presented in Table 15.3, reflecting observations for southeast England for 2040 – 2069.

Table 15.3 Temperature Variations in the Future Baseline

Season	2040 - 2069	2070 - 2099
Summer	+2.7 °C	+4.2 °C
Winter	+2.2 °C	+3.1 °C

15.3.2.2 Wind Speed

27. This section is based on the UK Climate Projections Science Report: Probabilistic Projections of Wind Speed[11] which has predicted summer and winter wind speeds for 2040 -– 2069 and 2070 – 2099. For southeast England, predicted summer wind speeds

[11] Sexton and Murphy (2010) UKCP09: Probabilistic Projections of Wind Speed [Online] Available at: http://ukclimateprojections.metoffice.gov.uk/media.jsp?mediaid=87876&filetype=pdf (Accessed 14/05/2018)

for 2040 – 2069, at the 50% probability level (under the medium emissions scenario), are slightly skewed towards a small reduction in wind speed, with changes predicted between 0 – 0.2 m/s which equates to around 0.4 knots. This is a minimal change compared with the typical magnitude of summer mean wind speeds for southeast England which is between 7 – 10 knots. Predicted summer wind speeds for 2070 – 2099, at the 50% probability level (under the medium emissions scenario), are -0.2 m/s which equates to roughly 0.4 knots. Similarly to the 2040 – 2069 projection period, this is a minimal change compared to the typical magnitude for winter mean speeds for southeast England.

28. Predicted winter wind speeds for 2040 – 2069 in southeast England at the 50% probability level (under the medium emissions scenario) are between -0.1 m/s to 0.1 m/s which equates to roughly 0.4 knots and is a relatively small changed compared to the mean observed winter wind speed value of between 10-14 knots over southeast England. Predicted winter wind speeds for 2070 – 2099, at the 50% probability level (under the medium emissions scenario), are -0.1 m/s which equates to roughly 0.4 knots which is also a relatively small change compared to the mean observed winter wind speeds over southeast England.

15.3.2.3 Sea Level Rise

29. This section is based on prediction presented in the UK Climate Projections Report: Marine and Coastal Projections Report[12].

30. Sea level for a particular region generally differs from the global mean. Local sea level is affected by ocean circulation and by geographical variations in the temperature and/or salinity of the water column. Sea level around the UK rose approximately 1 millimetre/year (mm/year) in the 20th century, corrected for land movement.

31. Long-term future predictions for 2070 – 2099 are based on major cities around the UK. London, the closest to the Development, predicts a 31.2 – 44.4 cm sea level rise, under the 50% probability level (under the medium emissions scenario).

15.3.2.4 Storm Surges

32. This section is based on predictions presented in the UK Climate Projections Science Report: Marine and Coastal Projections Report[10].

33. Around the UK coastline, the size of surge expected to occur on average about once in every 50 years is projected to increase by less than 0.9 mm/year during the 21st century. In most locations, this trend cannot be clearly distinguished from natural variability. In the UK, the largest storm surge trends are expected to be observed in the Bristol Channel and Severn Estuary, where the trend is for an increase in the 50 year skew surge return of around 0.8 mm/year.

15.3.2.5 Cloud Amount

34. This section is based on predictions presented in the UK Climate Projections Science Report.

35. Cloud cover is a key meteorological factor in determining the amount of solar radiation reaching the Earth's surface and is therefore, an imperative climate parameter in a solar development[13].

36. Cloud amount projections are based on UK-wide, mid-term projections up to the 2080s. Predicted winter cloud amount at the 50% probability level (under the medium emissions scenario) range from –9% to +6%. Summer predicted levels at the 50% probability level

[12] Lowe *et al.,* (2009). UK Climate Projections Science Report: Marine and Coastal Projections. Met Office Hadley Centre, Exeter, UK. [Online] Available at: http://ukclimateprojections.metoffice.gov.uk/media.jsp?mediaid=87906&filetype=pdf (Accessed 14/05/2018)
[13] Matuszko, D. (2011). Influence of the extent and genera of cloud cover on solar radiation intensity. International Journal of Climatology 32, 2403–2414.

(under the medium emissions scenario) have a higher range of up to -18% (-33% to -2%) in parts of southern England.

15.3.3 Greenhouse Gas Emissions

37. A substantial reduction in greenhouse gas emissions is imperative to avoid irreversible damage caused by the effects of climate change. Further to section 15.1.3, the UK Government has introduced a number of policies aimed at reducing greenhouse gas emissions and meeting renewable energy targets set at a UK, European and international level.

38. The Climate Change Act 2008[14] is legally binding legislation that creates a statutory framework for reductions in greenhouse gas emissions. A target reduction of 80% had been set for 2050 with two interim targets: a 34% reduction in emissions by 2030 and a 57% reduction in emissions by 2032. This Act includes a requirement for the UK secretary of state to ensure that the "*net UK carbon account for the year 2050 is at least 80% lower than the 1990 baseline*." This Act also requires local authorities to act in a way that contributes and helps deliver these emission targets. Additionally, the IEMA 'EIA Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance' assists greenhouse gas emissions assessment and mitigation in statutory and non-statutory EIA.

39. Table 5.3 of the Digest of United Kingdom Energy Statistics (DUKES) 2018[15] provides details of the sources used in generation of electricity throughout 2017 by major power producers. Of a total of 52.79 million tonnes of oil equivalent generated in 2017 within the UK, 27.9 million tonnes of oil equivalent were generated by natural gas, oil and coal, and 7.7 million tonnes of oil equivalent were generated from renewable resources. These numbers demonstrate that fuels which emit high levels of carbon emissions are generating the majority of electricity within the UK.

15.4 Assessment of Potential Effects

15.4.1 Vulnerability of the Development to Climate Change

40. Solar PV cells are designed to capture the sun's energy. Solar PV cells are therefore built to withstand extreme climatic conditions, and are purposefully located in open locations. However, solar energy developments could potentially be sensitive to significant changes in climatic variables, including atmospheric circulation and land cover changes as well as changes in sea level rise and storm surges, given the coastal location of the Development. The Development could also be sensitive to the frequency of extreme events (e.g., storms) which could damage solar panels or alter their efficiency.

41. Various studies regarding the potential effects of the environment on the Development have informed the design of the Development. These studies took into account of the changes in extreme wind speeds expected over the next decades, to ensure that the Development is not vulnerable to increases in maximum wind speed. The design of the mounting structures responded to a study to evaluate the maximum force that the wind could have on the solar panels.

42. As reported in Chapter 10: Hydrology, Hydrogeology, Flood Risk and Ground Conditions, modelling of flooding of the site under various disaster scenarios has been carried out, in consultation with the Environment Agency. These have taken account of climate change in line with consultee requests. As a result, the height of flood sensitive equipment has

[14] UK Government (2008) Climate Change Act 2008 [Online] Available at: https://www.legislation.gov.uk/ukpga/2008/27/contents (Accessed 10/05/18)
[15] Department for Business, Energy & Industrial Strategy (2018) Digest of United Kingdom Energy Statistics 2018 [Online] Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/736148/DUKES_2018.pdf (Accessed 25/10/18)

been increased to avoid effects in the event of the sea overtopping the sea wall, in a worst-case storm scenario in the year 2070. The inverters will be "string" type, mounted above the ground underneath the solar PV modules, and will similarly be above modelled flood levels. The transformer stations will be of floating (or other flood resilient) design, such that, in the unlikely event of a disastrous flood, they would remain safe. In addition, the substation/battery storage area has been designed to be within a bund of height above ordnance datum of c. 5.3 m, to prevent flood water reaching and damaging sensitive equipment in the event of a breach of the existing defences. These design features ensure that the Development is not vulnerable to increases in sea level, storm surges or catastrophic failures in flood defences.

43. The value of the receptor (the Development) is high, however, following the design measures set out above, the susceptibility of the Development to climatic changes in wind speed, sea level and storm surges is very low, and sensitivity overall is negligible.

44. Cloud cover, the change in which is set out in section 15.3.2.5, will most likely decrease in a future climate change baseline relative to the current baseline. This would improve the performance of the solar farm, providing increased energy from solar irradiation. This constitutes a minor beneficial effect.

45. Given the limited magnitude of the effect and the negligible sensitivity of the Development as an environmental receptor, there is no significant effect in terms of the EIA Regulations predicted as a result of changes in wind speeds, sea level rise, storm surges and cloud amount during the operational phase of the Development, nor from other climatic changes.

15.4.2 Influences of the Development on Climate Change

46. The influences of the Development on climate change are estimated through the emission or reduction in emissions of carbon dioxide (CO_2). As the operational phase of the Development is unlimited, calculations are provided for lifetimes of 25 years, the lifetime on which reference emissions data is based, and a more relevant approximate project timeframe of 40 years.

47. When operational, the Development will generate electricity from a renewable source and export this to the National Grid. The solar PV aspect of the Development is anticipated to have an installed capacity of approximately 330 MWp DC. Based on a simulation utilising the candidate design, east-west orientation proposed and other site specific parameters, the Development is anticipated to generate approximately 303,000 MWh of renewable electricity per year.

48. Constructing the Development will involve sourcing materials, manufacturing components, transporting them to site and installing them. The Development, when operational, will not emit substantial gases to the atmosphere[16], and hence not adversely contribute to climate change. Decommissioning the Development will involve removing components and reinstating the land, and transporting the components away from site. Each of these requires energy, and the production of much of that energy will involve the emission of CO_2 to the atmosphere. The IPCC (2014)[17] estimated full life-cycle emissions of CO_2 for a range of electricity generation types. For utility scale solar photovoltaic cells, it estimated an emission of 48 $kgCO_2eq/MWh$ (based on the median value from a range between 8 and 180 $kgCO_2eq/MWh$). In 2014, solar farms were expected to operate for 25 years, and the emissions data would have been based on this lifetime. The total CO_2

[16] During the operational phase, trivial emissions of carbon dioxide will be associated with service vehicles, maintenance equipment and occasional replacement parts.
[17] IPCC (2014): Annex III: Technology-specific cost and performance parameters. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Table A.III.2. Available at: https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_annex-iii.pdf [accessed on 25/10/2018]

cost of the Development is approximately 360,000 teCO_2 over 25 years on this basis. It should be noted that the CO_2 cost of the Development does not change if the lifetime changes, because the CO_2 cost is incurred during manufacture, construction and decommissioning.

49. The generation of electricity from the Development will displace the generation of electricity from other conventional power sources. Across the mix of sources of electricity that contribute power to the grid, the average emission of carbon dioxide (CO_2) in 2017 was estimated as 225 kg/MWh[18]. If this emission of CO_2 was avoided as a result of the Development, it would equate to approximately 68,000 teCO_2/y less entering the atmosphere and adversely contributing to climate change compared to the baseline scenario. It should be noted that new renewable energy schemes typically replace coal, oil or gas-fired electricity production, as in the energy market these are more often being decommissioned whilst renewable energy is not, rather than low-carbon electricity sources (other renewable energy or nuclear), and hence the above estimate of avoided carbon emissions is likely to be an under-estimate. On this basis, the CO_2 emissions of the Development (excluding the batteries) would be cancelled out within c. 5.3 years, and the CO_2 emission savings for any operational lifetime beyond that would a net benefit of the Development to reducing climate change.

50. As energy storage technology is relatively new to the UK, the CO_2 emissions impact of the energy storage aspect of the Development at the scale proposed is not readily quantifiable. IEMA states, in the 'EIA Guide to Greenhouse Emissions Assessment', that high level, qualitative assessment is acceptable particularly where data is unavailable, or mitigation measures are agreed. This is the approach followed in this section.

51. Investigation into the environmental effects of stationary batteries (Vandepaera et al)[19] demonstrates that the manufacturing stage drives the majority of environmental effects. This effect is greatly dependent on the percentage of fossil fuels in the electricity mix of the country of production. Romare and Dahllöf[20] concluded lifecycle greenhouse gas emissions of between 150-200 kg CO_2eq/kWh installed[21], following a literature review of life-cycle assessments on lithium-ion batteries. Although focussed on the production of batteries for light duty vehicles, the (limited) data available pointed to a near-linear scale up of greenhouse gas emissions when the battery size increases. Using the higher emissions factor, and based on the higher candidate design energy storage capacity of the project of 700 MWh (battery pack solution), this gives an emissions cost of approximately 140,000 teCO_2. This cost would be 'paid back' by a further c. 2.1 years' of operation of the solar PV modules as set out above.

52. This figure does not allow for any savings in CO_2 emissions and is therefore conservative. Energy storage assets provide significant benefits in both decarbonisation and security of supply, and these benefits increase when they are operated as part of a portfolio of renewable generators (e.g., Barnhart, 2018)[22]. Batteries are capable of capturing "free" energy when generation is greater than demand, and supplying it when demand is higher than generation. This assists with the operational management of the electricity network,

[18] BEIS (2018). DUKES 2018 Chapter 5: Electricity. Table 5D: Estimated carbon dioxide emissions from electricity supplied (2016, all fuels). Available at https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes [accessed on 25/10/2018].
[19] Vandepaera, L. *et al*. (2017) Environmental Impacts of Lithium Metal Polymer and Lithium-ion stationary batteries. Renewable and Sustainable Energy Reviews, Vol. 78, October 2017, p 46-60, Elsevier.
[20] Romare and Dahllöf (2017) The Life Cycle Energy Consumption and Greenhouse Gas Emissions from Lithium-Ion Batteries: A Study with Focus on Current Technology and Batteries for light-duty vehicles. IVL Swedish Environmental Research Institute Ltd.
[21] It may be useful to note that battery size is measured by the amount of energy that can be stored, in units of kilowatt-hours (kWh), whereas solar PV modules are measured by the amount of power they can generate, in units of kilowatts (kW).
[22] Barnhart, C. (2018). Energy and Carbon Intensities of Stored Solar Photovoltaic Energy. A comprehensive Guide to Solar Energy Systems pages 351-360, Academic press

especially when generation of electricity is variable (in addition to demand being variable), as it is with wind and solar power, which constitute the majority of renewable energy generation in the UK. Further detail on the renewable energy integrating and de-carbonising effect of battery storage is provided in the Needs Statement (DCO Document Reference 7.3), paragraphs 5.36 and 5.57.

53. The battery storage aspect of the Development has the potential to facilitate the use of the electricity generated by the solar PV aspect of the Development during peak times, or when electricity would otherwise be generated by fossil fuel sources. Although it is likely that the integration benefits of battery storage will enable further decarbonisation of the UK electrical grid, such decarbonisation is likely to be claimed by individual renewable energy development applications, and any specific, quantified accounting here could be seen as double-counting. Despite the enabling effect, therefore, no direct CO_2 emissions saving has been ascribed, in this assessment, to the operation of the energy storage facility.

54. The life-time emissions associated with the manufacture, construction and decommissioning of the solar and battery elements of the Development total approximately 500,000 teCO_2, therefore. Using the 68,000 teCO_2/y emissions saving, as above, this would lead to a total CO_2 emissions saving of approximately 1.2 million tonnes of CO_2 for a 25 year operational phase, or approximately 2.2 million tonnes of CO_2 for a 40 year operational phase.

55. This is considered to be a material, but non-fundamental, beneficial change to the UK's emissions of climate-changing gases and is therefore a moderate, positive environmental effect that is significant under the EIA Regulations.

15.4.3 Effects of Future Climate Change Scenario on Environmental Receptors Sensitive to Climate Change

56. The potential for environmental receptors to be impacted by the Development differently under an altered-climate scenario is assessed in other chapters, where appropriate. The effects of climate change, where these are non-zero, are summarised in Table 15.4.

Table 15.4 Climate Change Effects on Environmental Receptors

Chapter	Receptor	Climate Change Effect	Effect on Receptor
Chapter 7: Landscape and Visual Impact	Population, landscape character	Rise in sea levels	Negligible rise in sea levels results in no change to landscape baseline nor visual receptors during the operational phase of the Development.
Chapter 8: Ecology	Protected species, habitats	Increase in temperature	While a rise in temperature could affect the composition and growth rates of plant communities and invertebrates, and hence protected species and habitats, the uncertainties are high and it is not clear that the effect of the Development on those receptors would alter substantially as a result.
Chapter 9: Ornithology	Ornithology Population	Rise in sea levels	A rise in sea levels of 30-50 cm by 2070 corresponds to a substantial (albeit unquantified) change during the operational phase of the Development, and would result in a change in intertidal habitats.
		Rise in temperature	While a rise in temperature could affect migration paths and the intertidal zone within areas protected

Chapter	Receptor	Climate Change Effect	Effect on Receptor
			for their bird interests, the effect of the Development on those birds would not alter as a result.
Chapter 10: Hydrology, Hydrogeology, Flood Risk and Ground Conditions	Population	Rise in sea levels and increased surface water flooding	Rising sea levels have been modelled in the flood risk assessment. In addition an allowance for climate change has been made with regards to surface water flooding and coastal flooding. There is no effect on populations; the only potentially affected feature would be the Development and design measures have been implemented to minimise any effects.

57. The only potentially important change to environmental receptors considered elsewhere in this ES is the effect of sea level rise on ornithological receptors. This is considered in Chapter 9: Ornithology, section 9.3.3. Given the relatively limited magnitude of change in climate parameters predicted over the operational period of the Development, the baseline for other environmental receptors is not anticipated to change sufficiently affect the assessment of likely significant effects.

58. No additional significant effects are assessed as occurring as a result of climate change during the operational phase of the Development.

15.5 Mitigation Measures and Residual Effects

59. This CCIA identified that all adverse effects are of such limited nature that they are not significant and therefore no mitigation is required under the EIA Regulations or recommended as best practice.

15.6 Cumulative Effects

60. The UK Government has set ambitious targets for reducing greenhouse gas emissions by 2050. The Development, in conjunction with other renewable energy developments, will contribute to the UK's aims to reduce carbon emissions and achieve its ambitious greenhouse gas emissions reduction targets.

61. Table 5.3 of DUKES[23] 2018 details the sources used in generation of electricity throughout 2017 by major power producers. Renewable electricity represented 29.3% of total generation in 2017. As set out in Chapter 6 of DUKES 2018[24], solar PV represent approximately a third of total renewable electricity capacity installed in the UK. In 2017, 10.2% of total energy consumption came from renewable sources, as detailed within Table 6.7 of DUKES 2018[24].

62. The cumulative effect of the Development with other UK renewables generation is considered to be a fundamental change in the climate effects of UK energy supply, which is a major, positive, environmental effect that is significant under the EIA Regulations and will contribute to the UK's legally binding emission reduction targets.

[23] Department for Business, Energy & Industrial (2018) Digest of United Kingdom Energy Statistics (DUKES) (2018) [Online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/695804/Renewables.pdf (Accessed: 25/10/2018)

[24] Department for Business, Energy & Industrial (2018) Digest of United Kingdom Energy Statistics (DUKES) (2018) [Online] Table 6.7. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/736153/Ch6.pdf [accessed on 27/10/2018]

15.7 Summary of Effects

63. As a result of design measures, the predicted future climatic baseline conditions are highly unlikely to affect the operation of the Development.

64. The Development will have a moderate (and significant) beneficial effect on carbon emission savings, and a major (and significant) positive effect when considered cumulatively with UK-wide renewable energy deployment.

65. No significant effects, on receptors considered in other chapters of this ES, additional to those already identified will occur as a result of climate change during the operational phase of the Development.